International Journal of Industrial
Engineering & Technology (IJIET)
ISSN(P): 2277-4769; ISSN(E): 2278-9456
Vol. 5, Issue 1, Feb 2015, 13-18

TRANS STELLAR
• Journal Publications • Research Consultancy

A REVIEW ON SIX SIGMA METHODOLOGY IN MANUFACTURING INDUSTRIES

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ABSTRACT

Six Sigma has evolved as a powerful quality improvement methodology in many industries and its importance is growing. This paper presents that the concept of Six Sigma, DMAIC methodology used to implementation of Six Sigma especially for manufacturing industries. And some issues that are acting as critical successful factors for implementation of Six Sigma by manufacturing industries have been discussed. This paper describes the methodology, implementation and benefits of Six Sigma. At last some topics for future research are presented.

KEYWORDS: Critical Successful Factors, Process Capability, Normal Probability Distribution, Critical to Quality Requirements, DMAIC Methodology

INTRODUCTION

Six Sigma differs from other quality programs in its top down drive in its rigorous methodology that consists of detailed analysis, decisions based on facts, and a control plan to ensure continuous quality control of a process [7]. Six Sigma was started in Motorola by engineer Bill Smith in the late 1980s in order to address the company‘s chronic problems of meeting customer expectations in a cost effective manner [2]. Six sigma in manufacturing industries has been providing significant benefits, but there is no clarity in procedure regarding the exact parameters for six sigma implementation in industries [1]. All the organizations required to improve their production capabilities and management processes in order to survive long time in the market. This can be achieved by zero defects, improving processes, reduction in process variability, reduction in costs, increased profits, improve product quality and enhance productivity and increasing customer satisfaction [12].

The continuous quest for business improvement philosophies and methodologies like Six Sigma addresses the competitive pressure and challenges that all business sector faces to ensure their sustainability in the global market. Six Sigma is a quality improvement strategy that seeks to find and eliminate cause of defects or mistakes in business processes by focusing on outputs that are of critical importance to customers [6]. As a result, process performance should be enhanced, customer satisfaction should be improved and the bottom-line should be impacted through cost savings and increased revenue.

In statistical terms, Six Sigma means 3.4 defects per million opportunities, where sigma is used to represent the variation about the average of a process. The aim of Six Sigma is to keep the distance between the process average and the nearest tolerance limit to at least six standard deviations and thus reduce variability in products and processes in order to prevent defects. The concept of normal probability distribution curve as shown in figure 1 can be related to the concept of Six Sigma. Jayesh Pathak and Tusar Desai [8] stated that most processes are subject to disturbances that could cause the process mean to shift by 1.5 times standard deviation from the target. Factoring a shift of 1.5 standard deviation in the

process mean then results in a 3.4 defects per million opportunities.

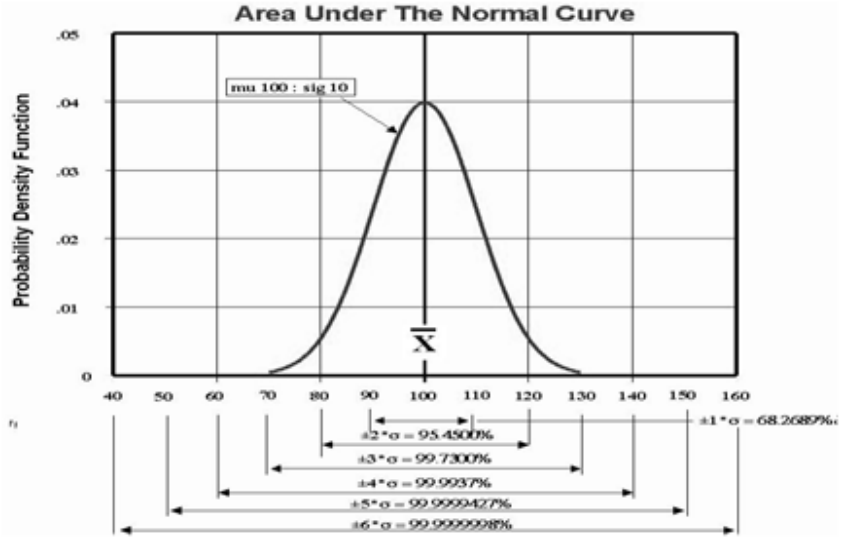

Figure 1: Normal Distribution (Six-Sigma) Curve [18]

ASSUMPTIONS IN SIX SIGMA

In applying Six Sigma there are several assumptions and they should be considered seriously. The most important assumptions are that each process can be characterized by a normal distribution but in real non-normal distribution are present. In this case the actual defect rate is higher than the predicted rates. Another assumption is that a 1.5 σ shift in the process mean is likely to occur and design goal of 6σ is necessary to provide a safe margin against such shifts [16]. But generally 6σ processes are under statistical control. Hence these shifts are detected at first opportunity or soon. Hence it is always not necessary to assume the mean shift. Final assumption is that defects are randomly distributed throughout units and process steps which are independent of each other. This may not be true in always such cases poison distribution for computing the defect rates and process yield might become invalid.

CRITICAL SUCCESSFUL FACTORS FOR SIX SIGMA IMPLEMENTATION

The key barrier to the implementation of Six Sigma in small medium enterprises (SMEs) has become lack of training and guiding for successful completion of project, but training program was too costly for SMEs [5]. At present, it is very easier in SMEs to get better external resources for guidance without paying more cost [17].

The Critical Successful Factors (CSFs) for Six Sigma implementation in many industries are:

- Poor participation of employee,
- Lack of training and knowledge,
- Internal resistance from the middle management,
- Lack of resources,
- Commitment from the top management
- Poor six sigma project selection etc.

These factors are playing very important role in Six Sigma implementation including SMEs.[13].

METHODOLOGY OF SIX SIGMA

Many models are available for process design and process improvement. Most of these models are based on PDCA cycle introduced by Quality philosopher Deming [15]. A paradigm of statistical concepts are embodied in Six Sigma's methodologies, which are used as the basis for carry out projects related to Quality management [11].

Six Sigma uses define, measure, analyze, improve, and control (DMAIC) methodology for process improvement or customer-oriented quality improvement (figure 2). Data and objective measurement is critical at each step of DMAIC framework. The standard statistical quality tools and techniques are incorporated at each step of the framework that makes Six Sigma unique from other continuous improvement initiatives [14]. After the define phase of the project, critical to quality characteristics and process variables are identified, discussed in the Measure and Analyze phase. This is followed by Improve phase where the optimal setting for process parameters are identified and tuned for a better performance. At the end in the Control phase, it is ensured that the resulting gains are sustained beyond the completion of the project [4].

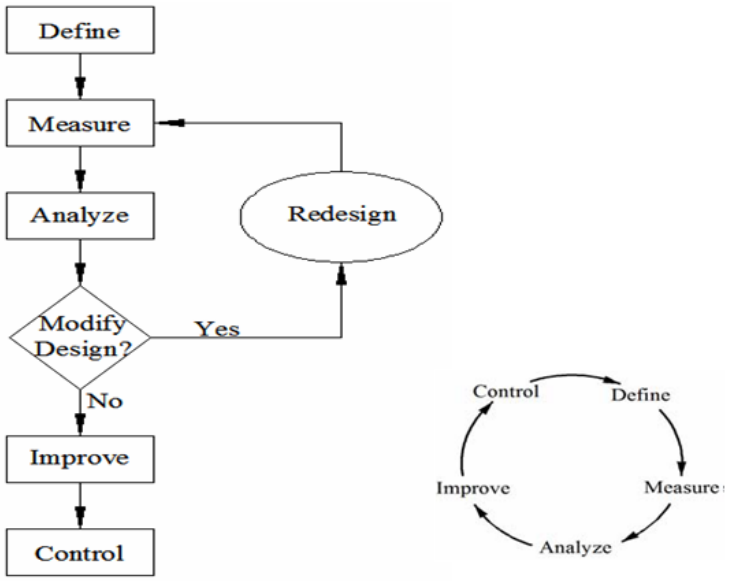

Figure 2: DAMIC Methodology [17]

DAMIC methodology consists of number of management and statistical tools and techniques in its respective phases. There are five steps in the conventional Six Sigma process: [3]

- **Define** – a business team first identifies suitable projects based on business objectives, customer needs, and feedback. The team identifies the critical to quality (CTQ) issues and other items that have an impact on quality and customer satisfaction.
- **Measure** – a problem-solving team then identifies and classifies likely internal processes influencing CTQ performance. Measurement system analysis, capability studies, and finding performance gaps dominate the work in this phase.
- **Analyze** – the team then works to find root cause and identify the underlying physics of the issue. This phase is not finished until root cause is found.

- **Improve** – the team then confirms key variables by measuring their effect on the CTQ characteristics. Actions are piloted and real tolerances established to deliver desired performance.
- **Control** – plans and actions are implemented to sustain the gains.

Table 1 Shows the Objective and Tools of Six Sigma Methodology

Table 1: Tools Used in Six Sigma Methodology

Define	Measure	Analyse	Improve	Control
Objective: DEFINE the opportunity	**Objective**: MEASURE current performance	**Objective**: ANALYZE the root causes of problems	**Objective**: IMPROVE the process to eliminate root causes	**Objective**: CONTROL the process to sustain the gains
Tools: 1. Cost of Poor Quality (COPQ) 2. Voice of the Stakeholder (VOS) 3. Project Charter	**Tools**: 1. Failure Modes and Effect Analysis (FMEA) 2. Critical to Quality Requirements (CTQs)	**Tools**: 1.Histograms, 2.Hypothesis Tests 3.Regression Analysis	**Tools**: 1.Solution Selection Matrix 2.To-Be Process Map(s)	**Tools**: 1.Control Charts

BENEFITS OF SIX SIGMA IMPLEMENTATION

Many industries including small and medium scale industries observing reduction in process variability, improvement in productivity, Improved Customer Loyalty and cost minimization to perform operations by implementing Six sigma programs[10],[19]. Linking Six Sigma program to employees will help in getting better cooperation from employees, improved work culture and boost morale. Linking Six Sigma with the suppliers will help in supplier participation in design the products, reducing product development cycle, which shall result in the effective implementation of Six Sigma. Sharing Six Sigma problem solving tools and techniques will allow for employee development and help create a climate and systems for employee motivation. Organizations can gain much by volunteering to implement Six Sigma rather than waiting for it to be imposed [9].

CONCLUSIONS

Six Sigma has evolved significantly and continues to expand since its inception at Motorola in the mid 1980s to improve the performance of its processes. Six Sigma is a powerful breakthrough improvement business strategy that enables industries to use simple statistical methods for achieving the sustaining operational excellence. Six Sigma is a disciplined approach consists of steps: define, measure, analyze, improve and control processes that result in reduction in process variability and zero defects. Six Sigma methodologies are applicable in both the manufacturing and service firms.

Application of continuous improvement strategies is not limited to any type or size of the organization. Large organizations have been reaping benefits since last three decades by implementing Six Sigma business strategy. Although Six Sigma has been implemented with success in many large scale industries, still there is less documented evidence of its implementation in smaller organizations due to lack of understanding and other pertinent constraints.

Critical Success Factors study showed that management involvement and commitment is the most important factor in successful deployment of Six Sigma. It is observed that there is a big gap in the level of importance and level of practice of CSFs within the organizations.

More research in the area of Six Sigma is still necessary to contribute to the concept and practice of implementation of Six Sigma and conceptual frame work for process improvement model to reduce waste and create value in the manufacturing industries.

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